been brought together with more painstaking care, probably, than has ever been used in the preparation of a catalogue of plants.—J. M. C.

A SECOND EDITION of Professor Atkinson's book on *Mushrooms* appeared recently from the press of Henry Holt & Company.[5] The new volume contains ten illustrations which did not appear in the first edition. The value and attractiveness of the work are further enhanced by a chapter on the cultivation of mushrooms, illustrated by half-tones of mushroom houses and flash-light photographs of mushroom beds in abandoned mines in New York and Pennsylvania. This chapter gives a good account of the status in the United States of an industry of whose existence probably few are aware. Methods of culture and marketing mushrooms are fully discussed in this chapter.

The typography and half-tone work of this edition are of the same excellent character as in the first edition, making it an exceedingly attractive work. —H. HASSELBRING.

THE SIXTH FASCICLE of Engler's great work on the genera and families of African plants was published in the spring of 1901, and just now, nearly three years later, the seventh fascicle[6] has made its appearance. It is a presentation of the genus Strophanthus (Apocynaceae) by E. Gilg, who recognizes 43 species, only one of which is new, but 8 of which are of recent publication by the author. The 10 lithographic plates, one of them colored, are models of illustrative work.—J. M. C.

NOTES FOR STUDENTS.

DIXON has examined the temperature difference between subterranean organs and the soil by a special thermopile.[7] He finds generally no higher temperatures than those of the soil and no diurnal periodicity other than is induced by periodic fluctuations of external temperatures. The adaptation of apparatus and discussion of errors in thermoelectric measurement of temperatures have a positive value.—C. R. B.

BOUILHAC AND GIUSTINIANI[8] believe that mixtures of bacteria with such algae as Nostoc and Anabaena will prove of great economic value in soils that are poor in nitrogen. Cultures of buckwheat supplied with these forms developed normally in soils deprived of all other organic matter, and subsequent tests showed that large quantities of nitrogen had been fixed. The control cultures of buckwheat developed poorly.—H. C. COWLES.

[5] ATKINSON, G. F., Studies of American fungi. Imp. 8vo. pp. vii + 323. *figs. 230.* New York: Henry Holt & Co. 1903. $3.

[6] ENGLER, A., Monographieen afrikanischer Pflanzen-Familien und -Gattungen. VII. Strophanthus, bearbeitet von E. Gilg. 4to. pp. 48. *pls. 10.* Leipzig: Wilhelm Engelmann. 1903. *M* 16.

[7] DIXON, H. H., Observations on the temperature of the subterranean organs of plants. Trans. Roy. Irish Acad. **32B**: 145–170. *pls. 5–8.* 1903.

[8] BOUILHAC and GIUSTINIANI, Sur une culture de Sarrasin en présence d'un mélange d'algues et de bactéries. Compt. Rend. **137**: 1274–1276. 1903.

MISS EDITH CHICK[9] has had an opportunity to examine a few seedlings of the Californian species of Torreya, a genus of the Taxaceae of special interest to the morphologist and of peculiar inaccessibility. The meager results confirm the preconceived opinions as to the primitive character of the genus. In the cotyledons there is such a primitive character as the presence of centripetal wood, while the lobing and adhesion of the cotyledons is a feature shared with such genera as Ginkgo and Zamia.— J. M. C.

IN A BULLETIN of the North Carolina Agricultural Experiment Station, Stevens and Sackett[10] describe a new wilt disease of the tobacco which has caused much damage in Granville county. Happily it is yet rather local, but it seems to be spreading. It appears to be due to bacteria which plug the tracheids and blacken the xylem, infection seeming to come through the roots. The disease becomes more and more intense with each crop and will necessitate the abandonment of affected fields unless means of prevention can be found or an immune race can be bred.— C. R. B.

ARBER[11] has presented to the Geological Society of London a paper describing the flora of the Cumberland coal-field. He enumerates twenty species from the Sandstone series and twenty-two from the productive measures. The lower beds of the Sandstone series are held to belong to the middle coal measures and the upper to the Transition coal measures. The productive measures are considered as of middle coal-measures age, the paleobotanical evidence for this conclusion being substantiated by the molluscan remains in the overlying strata. The paper, while describing no new species, is an admirable contribution to local stratigraphy. It is illustrated by two plates of the more interesting species and concludes with a brief bibliography.—E. W. BERRY.

ZELENY[12] has investigated the changes which take place in the position and size of leaflets of palmately compound leaves when one lateral leaflet is removed as early as possible. The remaining leaflets tend to form a new symmetrical system having one less member. This is attained chiefly by the movement of those leaflets which are left in an asymmetrical position with reference to the petiole. In *Lupinus albus* there was a frequent rotation of the leaf which placed the petiole in an interval different from that occupied by it when the operation was performed. Comparison of these leaves with the

[9] CHICK, EDITH, The seedling of *Torreya myristica*. New Phytologist **2**: 83–91, *pls. 7–8*. 1903.

[10] STEVENS, F. L., and SACKETT, W. G., The Granville tobacco wilt; a preliminary bulletin. Bull. 188, N. C. Agr. Exp. Sta. 1903.

[11] ARBER, E. A. N., Fossil flora of the Cumberland coal-field and the paleobotanical evidence with regard to the age of the beds. Quart. Jour. Geol. Soc. Lond. **59**: 1–24. *pls. 1, 2*. 1903.

[12] ZELENY, CHARLES, The dimensional relations of the members of compound leaves. Bull. N. Y. Bot. Garden **3**: 134–174. *figs. 13*. 1903.

normal showed that presence of the petiole between any two leaflets serves to widen the normal interval by about 37°. The leaflets of the leaves operated on were in each instance shorter than those of the normal leaves.— G. H. SHULL.

REINKE DISCUSSES the available sources of nitrogen for algae, especially marine forms, and concludes that those which he and others have named heretofore, particularly the additions from the offal of cities, are entirely inadequate.[13] In Kiel harbor, nitrogen bacteria (*i. e.*, species capable of fixing free N dissolved from the air) have been found, notably *Clostridium Pasteurianum* and *Azotobacter Chroococcum*, both in the mud at the bottom and in the mucilage covering the fronds of Laminaria, etc. Indeed, the latter are like agar plate-cultures of such species. Reinke suggests, therefore, that this is a sort of symbiosis, inevitably recalling the association of Rhizobia with Leguminosae, in which the bacteria get carbohydrates from the algae and give them nitrogenous compounds produced by the fixation of free N.—C. R. B.

J. ERIKSSON[14] has pointed out that Professor Marshall Ward's attack upon his mycoplasm hypothesis does not distinguish between the two essential points involved. The first is the existence of an internal germ of disease; the second the form in which such an internal germ may be conceived of as existing. The former point Eriksson would regard as proved, the latter as purely hypothetical; and hence he sees no reason why rejection of the latter should involve repudiation of the former. He calls attention to the fact that Professor Ward's work was carried on with artificial infections, when the whole theory rests upon outbreaks of the disease which cannot be explained by external infection; the theory having to do with that may be called the first stage of the disease, and Professor Ward's experiments with the second stage.—J. M. C.

N. BERNARD has discovered some interesting peculiarities about the germination of orchids.[15] Seeds of Cattleya and Laelia germinate readily in about fifteen days, soon developing into minute green spherules. The plants rest here for some time and later slowly develop into a top-shaped body, which is always infested at the suspensor end by an endophytic fungus. In aseptic cultures the seedling does not go beyond the spherule stage, whence Bernard concludes that fungi are necessary even in the early stages of the orchid plant. By introducing the proper fungi, the ordinary slow growth may be much accelerated, and the resting period after the spherule stage may be much

[13] REINKE, J., Zur Ernährung der Meeres-Organismen disponiblen Quellen an Stickstoff. Ber. Deutsch. Bot. Gesells. **21**: 371–380. 1903.

[14] ERIKSSON, J., The researches of Professor H. Marshall Ward on the brown rust on the bromes and the mycoplasm hypothesis. Arkiv för Botanik **1**: 139–146. 1903.

[15] BERNARD, N., La germination des Orchidées. Compt. Rend. **137**: 483–485. 1903.

abbreviated. The author concludes by stating that we have here an embryo which cannot develop without fungal symbiosis, just as an egg commonly has to be fertilized before it can develop.— H. C. COWLES.

A PAPER BY HELLER[16] on the influence of ethereal oils and the like upon plants comes from the Leipzig laboratory. Plants were subjected to the influence of such substances as the oils of Eucalyptus, Citrus, Salvia, Thymus, Origanum, Mentha, Pinus, etc., and of gum camphor, thymol, etc., as well as of petroleum ether, petroleum, benzine, benzene, xylene, anilin, phenol, etc. These substances are more poisonous in vapor form than as liquids or in aqueous solution. Plants which produce an oil are somewhat immune to its action. Volatile hydrocarbons act like ethereal oils. As would be expected, all these substances enter the cell by going into solution in the water of imbibition of the cell walls and then diffusing as solutes. But, as would not be expected, a dry membrane appears to be a poorer protection to the plant than a moist one. Resin and paraffin failed to gain an entrance into the cells.— B. E. LIVINGSTON.

DIXON has replied to criticisms of the cohesion theory of the ascent of water[17] by Steinbrinck and by Copeland. To Steinbrinck's contention that the permeability of lignified walls to air renders the Dixon-Joly theory untenable, he replies briefly that the gas is chiefly in solution, in which state, as had already been shown, it does not interfere with the transmission of tensions in water columns. Furthermore, even if the gas is free it only interrupts the function of the vessel in which it develops. Chief attention is given to Copeland,[18] whose methods and interpretations are criticized. Dixon holds that the manometers as arranged in Copeland's apparatus indicate only local differences of gas pressure and of water pressure, the latter produced by long continued absorption of water after the plaster has set. This peculiarity of plaster may be a source of error in Copeland's work; the other criticisms do not appear valid to one familiar with his experimentation.—C. R. B.

THE POLLEN TUBE structures of *Cupressus Goveniana*, as recently described by Juel,[19] are extremely interesting. Up to the division of the body cell, the sequence is as in other members of the Cupresseae, there being a stalk nucleus, a tube nucleus, and a body cell. The body cell, however, instead of giving rise to two sperm cells, gives rise to a cell complex consisting of a variable number of cells, sometimes four, oftener eight or ten,

[16] HELLER, A. Ueber die Wirkung ätherischer Öle und einiger verwandter Körper auf die Pflanzen. Flora **93**: 1–31. 1903.

[17] DIXON, H. H., The cohesion theory of the ascent of sap. Sci. Proc. Roy. Dublin Soc. **10**[1]: 48–61. 1903.

[18] COPELAND, E. B., The rise of the transpiration stream: A historical and critical discussion. BOT. GAZ. **34**: 161–193, 260–283. 1902.

[19] JUEL, H. O., Ueber den Pollenschlauch von Cupressus. Flora **93**: 56–62. *pl. 3.* 1904.

and in a few very vigorous tubes about twenty. All other living gymnosperms yet described have but two sperm cells. The pollen grains of Cordaites contain a cell complex which has been interpreted as an antheridium. The cell complex in Cupressus seems to be similar, although in Cordaites it is formed in the pollen grain, while in Cupressus is formed later in the pollen tube. *Callitris quadrivalvis* was also examined, but the pollen tube structures are practically the same as described by Belajeff for Juniperus and by Land for Thuja.—C. J. CHAMBERLAIN.

ZEILLER AND FLICHE[20] have discovered fossil remains of Sequoia in Portlandian beds near Boulogne-sur-Mer. This is a discovery of great importance, since Sequoia has not previously been reported from Jurassic strata. Even at this early date the generic characters were well marked, and some of the specific characters of *Sequoia gigantea* were present. Of no less importance is the finding of Pinus in the same beds, one of the Strobus type, and one more like *P. Laricio.* Pinus is thus surely established as a Jurassic genus, and largely differentiated as now. Although Jurassic pines have been reported at least three times in as many places, not till now has there been such undoubted evidence. Perhaps most remarkable of all is the fact that this oldest of known pines is in no sense generalized or archaic, but belongs to the most highly specialized group of pines as they exist today. Thus in the pines, as in so many plants and animals, are the first known forms as highly specialized as any which come later.—H. C. COWLES.

MATHEWS[21] has hit upon what seems to be a generalization of rather broad significance in his work upon the toxic action of ions upon eggs of Fundulus. Since this may well apply to plant protoplasm as well as to that of animals, it would be well for plant physiologists who are working with poisons to be familiar with it. The hypothesis is briefly this: The physiological action of both kations and anions is an inverse function of their solution tension, *i. e.*, their affinity for their electric charge. Thus "mercury, silver, and copper are poisonous because they part with their charges to the protoplasmic particles easily, thereby bringing about changes in the state of aggregation of the colloidal particles, and decomposition of the molecules." The physiological action of a salt is, therefore, an inverse function of the sum of the solution tension of its resulting ions. There seems also to be an inverse relationship between atomic volume and toxicity, and a direct relation between this and equivalent weight. Poisonous action of metals would thus appear to be a "periodic function of their atomic weights." While the evidence is fairly in unison, the hypothesis must needs be tested much further before it is fully established.—B. E. LIVINGSTON.

[20] ZEILLER, R., and FLICHE, P., Découverte de strobiles de Sequoia et de Pin dans le Portlandien des environs de Boulogne-sur-Mer. Compt. Rend. 137:1020–1022. 1903.

[21] MATHEWS, A. P., The relation between solution tension, atomic volume, and the physiological action of the elements. Am. Jour. Physiol. 10:290–323. 1904.

ACCORDING TO Molliard and Coupin[22] the sterigmata and basidia of *Sterigmatocystis nigra*, when grown in a medium without potassium, have a remarkable tendency to grow out into mycelial filaments instead of producing conidia in the normal way. These filaments sometimes enlarge to form secondary conidial heads, which in turn may proliferate again. Finally some conidia are produced, but of smaller size and with thinner walls than normally occurs. Often these conidia appear on the ends of simple radiating branches without a central head, somewhat after the manner of Penicillium; or the swollen head may be produced with its basidia, which bear conidia directly without the intervention of sterigmata at all, somewhat as in Aspergillus. Conidia which germinate in absence of potassium are apt to produce chlamydospores very soon, sometimes immediately upon germination. The control cultures, wherein the fungus grows normally, differ from those which exhibit the above phenomena only in the presence of 0.6^{gm} of K_2CO_3 in 1500^{cc} of medium. Both control and experiment cultures contain 0.4^{gm} of $MgCO_3$, so it is hardly possible that the response is due to the anion CO_3. The difference in osmotic pressure between the two is so slight as to be negligible. The last two points are not considered by the authors.—B. E. LIVINGSTON.

IN A SERIES of digestion experiments upon the mannans and galactans of certain leguminous and other seeds and of the tubers of several orchids, Hérissey has demonstrated a new enzyme, or group of such bodies, which he terms seminase.[23] Seminase is a soluble ferment, best obtainable from alfalfa (lucerne), but it has been found in *Aspergillus niger* and to some extent in the tubers of certain Orchidaceae. It has the power to render soluble both mannans and galactans, producing mannose and galactose, respectively. Alfalfa seeds which have been germinated at a temperature of 27–30° C. for from 36 to 48 hours yield the maximum amount of the ferment. The body obtained from these seeds acts upon the carbohydrates of other seeds, upon those of orchid tubers, etc., but fails to have any effect upon those of palm seeds, although the latter yield mannose when hydrolyzed with weak mineral acid. Although the seeds of alfalfa, etc., even in the resting state, contain seminase, yet at no stage of their germination has the author found mannose or galactose present in quantity sufficient for identification. Cane sugar is generally present, however, and the author believes that mannose and galactose are only a transition state, and that these bodies pass as soon as formed into some other carbohydrate, perhaps cane sugar.—B. E. LIVINGSTON.

[22] MOLLIARD, M., and COUPIN, H., Influence du potassium sur la morphologie du *Sterigmatocystis nigra*. Rev. Gén. Bot. 15:401–405. *pl. 17*. 1903.

[23] HÉRISSEY, H., Recherches chimiques et physiologiques sur la digestion des mannanes et des galactanes, par seminase, chez les végétaux. Rev. Gén. Bot. 15:345–368, 406–417, 446–463. 1903.

DOUGLAS H. CAMPBELL[24] has published a second paper upon the Araceae, dealing chiefly with *Aglaonema commutatum* and *Spathicarpa sagittaefolia.* In the former species the embryo-sacs vary in number from one to three, and where two or three are formed they may be derived from a single archesporial cell or may possibly originate independently from hypodermal cells. The most interesting feature, however, is the variation in the number of nuclei in the embryo-sac, this ranging from four to twelve and with slight indication of polarity. Multiple nuclear-fusions are of common occurrence, and it is often impossible to be certain which of the structures represent the egg-apparatus and which the antipodal cells. The embryo of this species also conforms to what seems to be an aroid type, namely a large mass of cells with little differentiation of external parts and with tissues almost completely homogeneous.

In Spathicarpa the embryo-sac is of the ordinary angiospermous type, but after fertilization the antipodals become greatly enlarged and one of them may divide. The embryo remains small and the external organs are evident, but the tissues are only slightly developed.

In both species the development of endosperm proceeds gradually from the base of the embryo-sac until it is completely filled.— J. M. C.

DEANE B. SWINGLE[25] in his study of the formation of spores in Rhizopus and Phycomyces has summarized the essential features of the process as follows: (1) streaming of the cytoplasm, nuclei, and vacuoles up the sporangiophore and out toward the periphery, forming a dense layer next the sporangium wall and a less dense region in the interior, both containing nuclei; (2) formation of a layer of comparatively large, round vacuoles in the denser plasm parallel to its inner surface; (3) extension of these vacuoles by flattening so that they fuse to form a curved cleft in the denser plasm; and, in the case of Rhizopus, the cutting upward of a circular surface furrow from the base of the sporangium to meet the cleft formed by these vacuoles, thus cleaving out the columella; (4) division of the spore-plasm into spores; in Rhizopus, by furrows pushing progressively inward from the surface, and outward from the columella cleft, both systems branching, curving, and intersecting to form multinucleated bits of protoplasm, surrounded only by plasma-membranes and separated by spaces filled with cell sap only; in Phycomyces, by angles forming in certain vacuoles containing a stainable substance and continuing outward into the spore-plasm as furrows, aided by other furrows from the columella cleft, and dividing the protoplasm into bits homologous with and similar to those in Rhizopus, and separated by furrows

[24] CAMPBELL, DOUGLAS H. Studies on the Araceae. The embryo-sac and embryo of Aglaonema and Spathicarpa. Ann. Botany **17**: 665–687. *pls. 30–32.* 1903.

[25] SWINGLE, DEANE B., Formation of the spores in the sporangia of *Rhizopus nigricans* and of *Phycomyces nitens.* pp. 40. *pls. 6.* Bulletin 37, Bureau of Plant Industry. 1903.

partly filled with the contents of the vacuoles that assist in the cleavage; (5) formation of walls about the spores and columella, and, in the case of Rhizopus, the secretion of an intersporal slime; (6) partial disintegration of the nuclei in the columella.—J. M. C.

WHAT SEEMS a careful study of the effect of certain external conditions upon the evolution of oxygen by some green water plants has been made by Pantanelli.[26] He finds that the curve of oxygen production with varying light intensity shows a distinct optimum (at about one-fourth the intensity of direct sunlight), beyond which it falls as light increases, unless the supply of CO_2 is varied at the same time, in which case the optimum would be displaced in the direction of weaker light with less CO_2, and toward the stronger light with more CO_2. The regulation of the activity of the chloroplasts is not instantaneous, five to ten minutes passing before a change in their activity can be ascertained. Ultra-optimal light stops protoplasmic streaming, and, if excessive, produces aggregation and diminishes the evolution of O_2. Furthermore, and independently of these changes, it produces in the chloroplasts phenomena of fatigue like those of an isolated muscle, which pass away gradually after the return of normal conditions, the slower the more complete the fatigue. By light intense enough to diminish the decomposition of CO_2 the chlorophyll pigment is attacked. After such injury it is never reformed. The evolution of O_2 increases with the increased content of CO_2 in the water to an optimum, and then decreases, unless the light varies correspondingly. The bubbles of gas given off, however, continue to increase beyond the CO_2-optimum, but contain more and more CO_2, which merely diffuses through the plant unchanged.

Pantanelli also finds that various solutes exercise a marked influence upon photosynthesis, for which details the original must be consulted. He holds the chief result of his work to be the demonstration that the plasmatic portion of the chloroplasts works, tires, and recuperates, the chlorophyll remaining primarily wholly indifferent; but if the plasmatic stroma becomes injured, the chlorophyll immediately suffers photochemical oxidation. Normally, however, its lability does not appear, because it is constantly protected by the plasma. Nothing, he thinks, indicates that in strong light chlorophyll is continually decomposed and regenerated—an assumption of those who look upon chlorophyll as a sensitizer.—C. R. B.

ITEMS OF TAXONOMIC INTEREST are as follows: G. F. ATKINSON (Ann. Mycol. 1: 479–502. *pl. 10.* 1903) has discussed the genus Harpochytrium in the United States.—F. v. HÖHNEL (*idem* 522–534) has described the following new genera of fungi: *Bresadolella* (Nectriaceae), *Myxolibertella* (Melanconieae), *Sporodiniopsis* (Hyphomycete), *Cirrhomyces* (Dematieae), *Aegeritopsis* (Tuberculariaeae).—R. PILGER (Engler's Pflanzenreich IV. 5. p. 117.

[26] PANTANELLI, ENRICO, Abhängigheit der Sauerstoffausscheidung belichteter Pflanzen von äusseren Bedingungen. Jahrb. Wiss. Bot. **39**: 167–228. 1903.

1903) has described a new genus (*Acmopyle*) of Taxaceae.—C. S. SARGENT (Proc. Rochester Acad. Sci. 4: 93–106. 1903), in a presentation of the genus Crataegus as displayed in and about Rochester, N. Y., has described 27 new species.—W. R. MAXON (Contrib. U. S. Nat. Herb. 8: 271–276. *pls. 61–62.* 1903), in studying certain Mexican and Guatemalan species of Polypodium, has described 5 new species.—A. W. EVANS (Ottawa Nat. 17: 13–24. *pls. 1–2.* 1903), in a paper on Yukon Hepaticae, embracing 38 numbers, has raised to generic rank Mesoptychia, one of Lindberg's sections of Jungermannia, and more recently a subgenus of Lophosia.—E. L. GREENE (Leaflets 1: 1–32. 1903) has published, as segregates from Aster, *Oclemena* (*A. acuminatus* and *A. nemoralis*), *Lasallea* (*A. sericeus* as type), and *Unamia* (*A. ptarmicoides*); has recognized *Kyrstenia* Necker (Eupatorium § Ageratina) as entitled to generic rank, transferring the numerous species involved and describing 9 new ones; has described as a new genus *Uncasia* (to include *Eupatorium perfoliatum* and its numerous allies); in discussing certain genera of Polygonaceae, has recognized the generic rank of *Bistorta*, transferring the species and describing 6 new ones, and of *Duravia* and *Persicaria*, describing 11 new species under the latter.—J. R. JOHNSTON (Proc. Amer. Acad. 39: 279–292. 1903). has published a revision of the genus Flaveria, recognizing 15 species, 4 of which are described as new.—N. L. BRITTON and J. N. ROSE (Bull. N. Y. Bot. Gard. 3: (no. 9), 1–45. 1903), in publishing "new or noteworthy North American Crassulaceae," have described as new genera *Oliverella*, *Clementsia*, *Villadia*, *Urbinia*, *Gormania*, *Dudleya*, *Altamiranoa*, *Stylophyllum*, *Hasseanthus*, and *Sedella*, besides 101 new species.—R. S. WILLIAMS (*idem* 104–134), in reporting on a collection of Bolivian mosses, has described 3 new genera (*Chrysoblastella*, *Teretidens*, *Aligrimmia*) and 29 new species.—W. B. HEMSLEY (Jour. Linn. Soc. London 35: 517. 1903) has published a new genus of Cyrtandraceae (*Rhabdothamnopsis*) from China.—C. S. SARGENT (Trees and Shrubs, part III) has published new species Crataegus (6), Euonymus, Viburnum, Pinus (W. Indies), and a new Mexican genus (*Gryphocarpa*) of Compositae by Greenman.—A. A. HELLER (Muhlenbergia 1: 31–46. 1904) has described new species of Scutellaria (2), Agastache, Stachys, Monardella (5), Veratrum, Holodiscus, Boisduvalia, Gilia, Pentstemon, and Orthocarpus.—P. HENNINGS (Hedwigia 42: 307. 1903) has described a new genus (*Biatorellina*) of Patellariaceae, and one (*Squamotubera*) of Xylariaceae.—Three new species of Opuntia left in manuscript by the late DR. WEBER have just been published (Gard. Chronicle III. 35: 34. 1904).—W. SUKSDORF (West Am. Scientist 14: 31–33. 1903) has published three new species of Nemophila.—J. M. C.

A. A. LAWSON[27] has obtained some most interesting results from a study of *Sequoia sempervirens*, whose essential morphology has long been a desideratum.

[27] LAWSON, A. A., The gametophyte, archegonia, fertilization, and embryo of *Sequoia sempervirens*. Ann. Botany 18: 1–28. *pls. 1–4.* 1904.

The reduction division preceding the formation of pollen mother-cells occurs during the first week in December. Pollination occurs during the first week of January, each microspore containing tube and generative nuclei, with no trace of prothallial cells. The microspores remain in the micropyle three or four weeks before further germination, when tubes are put forth and pass in various directions, some between the integument and nucellus, others directly into the nucellus. No branching of tubes was found, as reported by Shaw. At this time the division of the generative nucleus into stalk and body nuclei was observed, the latter becoming surrounded by a dense mass of cytoplasm invested by a membrane. The maturity of the body cell was obtained at various times between early in May to the middle of June. The spindle organized for the formation of the male cells was found, but no trace of an organ suggesting a blepharoplast could be observed.

Five or six megaspore mother-cells become differentiated rather deep in the nucellus, and each one divides twice (about March 1), but develops only two megaspores. The ten or twelve megaspores begin to germinate, but only two or three get beyond the first division and continue to elongate toward the chalaza, and one of these soon becomes dominant. Free nuclear division occurs in the two extremities of the embryo sac, and at the last division neighboring nuclei become connected by radiating fibrils, and cell plates are formed. The development of the endosperm takes about three months, archegonium initials appearing during the first week in June.

Numerous archegonium initials become differentiated deep in the micropylar region of the prothallium, the neck cells being forced toward the periphery of the endosperm by the elongation of the central cells. Two neck cells were observed, confirming Arnoldi, though occasionally four were formed. The nucleus representing the ventral canal cell was also observed, which, in the absence of a cell plate and on account of its ephemeral existence, may well have escaped the earlier observers. A remarkable feature in connection with the archegonia is that their necks are directed toward the nearest lying pollen tubes, which have taken up various positions before the archegonia are formed.

Fertilization is unique in the fact that only the male nucleus, with a very small amount of cytoplasm, leaves the tube and enters the archegonium, the denucleated male cell retaining its form in the pollen tube. In fusion the two chromatin masses form a common network, and the male and female constituents become indistinguishable. As a rule, the two male cells fertilize two neighboring archegonia. The development of the embryo is also a decided departure from the ordinary early stages observed in conifers, in that there is no free nuclear division. The first division of the egg nucleus results in two walled cells, so large that they almost fill the egg. Subsequent divisions result in a row of five large cells, the lowest of which gives rise to the embryo, and the next above to the suspensor. In the first spindle of the embryo the chromosomes were estimated to be thirty-two in number, and in the endosperm enough was observed to indicate that the number was approximately sixteen.—J. M. C.

ORIGIN OF THE OVULE.—Paleobotanical evidence for the origin of the ovule is accumulating with remarkable rapidity. In discussing the ovules of the older gymnosperms, F. W. Oliver[28] has described some most significant structures. The two ordinary types of unassigned paleozoic seeds are called for convenience Radiospermae and Platyspermae, the former including radially symmetrical seeds, the latter flattened ones. The simplest form is known as Stephanospermum (a radiosperm), in which the nucellus stands up freely within the integument: the apex of the nucellus is occupied by an extensive pollen-chamber; and "the chalazal strand of tracheids expands at the base of the nucellus into a tracheal plate, the margins of which are continued in the wall of the nucellus right up to the pollen chamber, the floor of which is paved with tracheids." The pollen grains are multicellular, and apparently liberated free-swimming sperms. The tracheal mantle of the nucellus is thought to be a mechanism for bringing water to the pollen-chamber, to be of use to the swimming sperms. This promiscuous liberation of swimming sperms is thought to be reminiscent of a heterosporous pteridophyte.

Among the platysperms (Cardiocarpus as type) there is the same tracheal plate at the base of the nucellus, from which tracheal strands extend into the walls of the nucellus at least as far as the separation of integument and nucellus. In this case the tracheal mantle, so far as known, is not so complete as in Stephanospermum. Moreover, the pollen grains are multicellular, but the cell-group by no means fills the entire grain. It is evident that the platysperms approach the cycads much more nearly in these particulars than do the radiosperms.

One of the most striking seeds, however, is that of Lagenostoma, from the lower Coal Measures. The integument and nucellus are free from one another only in the region of the pollen chamber, from the floor of which a conical mass of nucellar tissue rises, plugging up the micropyle (a structure, by the way, resembling that described by Hirase in Ginkgo), leaving the cavity of the pollen chamber a circular crevice. Surrounding the pollen chamber is the very complicated integument, consisting of an outer zone of heavy tissue, and an inner zone of large chambers separated by strong radiating plates. The internal angle of each chamber is convex, the inner wall of the integument thus forming a fluted membrane known as the "canopy." It seems that each of the large, vertical chambers of the integument was occupied by soft parenchyma, through which there ran longitudinally a single tracheal strand. In this case, also, the pollen grains were filled with tissue, indicating free-swimming sperms, and the more or less complete tracheal mantle would

[28] OLIVER, F. W., The ovules of the older gymnosperms. Ann. Botany 17: 451–476. *pl. 24.* 1903.

represent the essentials of a contrivance for supplying the pollen chamber with water. The unique thing in Lagenostoma, however, is the peculiarly chambered integument.

Professor Oliver also calls attention to the general resemblance of modern cycads in the features described for radiosperms and platysperms, the main difference being found in the fact that only at the apex are nucellus and integument free from one another. Moreover, he describes the distribution of the vascular system in the cycadean ovule as probably derived from the vascular mantle found in the paleozoic seeds. He accounts for these differences, and also for the fact that among the cycads the integument and nucellus are distinct only at apex, while among the paleozoic seeds they are distinct to the base of the ovule or nearly so, by assuming that between the original ovule and its insertion a new region has been intercalated, resulting in a retreat of the nucellar bundles from the pollen chamber.

The remarkable case of Torreya is also introduced, whose anatomy suggests that it is the most archaic of living conifers, fuller details of which we are promised in a forthcoming memoir. Strong tracheal branches extend upwards from the tracheal plate at the base of the nucellus, and ultimately send branches into the nucellus which connect with a peculiar mucilage layer that may be a modification of the palaezoic tracheal mantle. It will be remembered that the other conifers have lost their nucellar vascular systems.

About the time the preceding paper was going through the press, Mr. Oliver and D. H. Scott[29] made preliminary announcement that the peculiar seeds of Lagenostoma, described above, belong to the genus Lyginodendron, one of the Cycadofilices of Potonié. The evidence for the intermediate position of this group has been drawn entirely from anatomical vegetative characters, and the discovery of fructifications was looked forward to with peculiar interest. An undescribed species of Lagenostoma showed young seeds inclosed in a husk or cupule, whose peculiar glands and whose internal anatomical structure were only duplicated in the vegetative organs of Lyginodendron. This genus, therefore, in its vegetative structure retains the intermediate position already assigned to it, but had fully attained the seed-habit.

On January 21, 1904, the same authors[30] presented their full paper to the Royal Society, and in connection with a discussion of the systematic position of Lyginodendron proposed the establishment of a distinct class, under the name *Pteridospermae,* to "embrace those paleozoic plants with the habit and much of the internal organization of ferns, which were reproduced by means of seeds." The opinion was ventured that not only Lyginodendrae but

[29] Oliver, F. W., and Scott, D. H., On *Lagenostoma Lomaxi,* the seed of Lyginodendron. Ann. Botany 17: 625–629. 1903.

[30] Oliver, F. W., and Scott, D. H., On the structure of the paleozoic seed *Lagenostoma Lomaxi,* with a statement of the evidence upon which it is referred to Lyginodendron. Abstract preprint.

also Medullosae would be removed from Cycadofilices and included among Pteridospermae.

And now, in a note issued January 27, Professor Oliver[31] announces the discovery of three specimens of fragments of fronds of *Neuropteris heterophylla*, each bearing a large seed. As this Neuropteris is without doubt the foliage of a Medullosa, the two families Lyginodendrae and Medullosae, as prophesied, at present represent the known forms of Pteridospermae. While the new group is distinctly intermediate between Filicales and Gymnospermae, the undoubted seeds would include it among gymnosperms as at present constituted, although the form of the name would indicate the intention of proposing it as a third group of seed-plants.

Associated with the above results is a recent contribution by Miss Margaret Benson[32], who supports the theory of the soral origin of the ovule, and proposes an entirely new theory of the phylogeny of the inner integument. She finds that certain digitate clusters found among paleozoic plant remains are synangia that have dehisced septicidally and then opened along the ventral sutures for the liberation of spores. Telangium is a form-genus proposed to include such forms as were studied, and proofs are advanced to show that it is the microsporangial sorus of Lyginodendron. If this be true, the information concerning Lyginodendron has developed rapidly, and its intermediate character would be still further emphasized by the possession of a distinct ovule (Lagenostoma) and a microsporangial synangium (Telangium). In our own observation this is exactly paralleled by the case of Cycadoidea in which ovules are associated with synangia.[33] The most far-reaching suggestions of the paper, however, have to do with the origin of the ovule and the nature of the inner integument. The conclusion that the microsporangium of Lyginodendron is a synangium suggested that the megasporangium (Lagenostoma) of the same form might be derived from a synangium whose sterile sporangia are still represented by the anomalous cavities of the integument surrounding the functional sporangium, as described above. This interpretation of the "canopy" of Lagenostoma is supported by a number of arguments, including such analogies as may be obtained from the megasporangial sorus of Azolla, and the sterilized sporangia in the tufted sori of Botryopteris. This means that the ovule is a synangium in which the peripheral sporangia are sterilized and specialized as an inner integument!—J. M. C.

[31] OLIVER, F. W., A new pteridosperm. New Phytologist 4: 32. 1904.

[32] BENSON, MARGARET, *Telangium Scotti*, a new species of Telangium (Calymmatotheca) showing structure. Ann. Botany 18: 161–177. *pl. 11*. 1904.

[33] See COULTER and CHAMBERLAIN, Morphology of Spermatophytes. Part I. Gymnosperms. pp. 145–148.